Supporting Information

Bifunctional Imidazolium Linked Tetraphenylethene Based Conjugated Microporous Polymers for Dynamic Antibacterial Properties and Supercapacitor Electrode

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Characterization

FTIR spectra were collected on a Bruker Tensor 27 FTIR spectrophotometer with a resolution of 4 cm⁻¹ by using KBr disk method. ¹³C nuclear magnetic resonance (NMR) spectra were examined by using an INOVA 500 instrument with DMSO as the solvent and TMS as the external standard. Chemical shifts are reported in parts per million (ppm). The thermal stabilities of the samples were performed by using a TG Q-50 thermogravimetric analyzer under a N₂ atmosphere; the cured sample (ca. 5 mg) was put in a Pt cell with heating rate of 20 °C min⁻¹ from 100 to 800 °C under a N₂ flow rate of 60 mL min⁻¹. Wide-angle X-ray diffraction (WAXD) patterns were measured by the wiggler beamline BL17A1 of the National Synchrotron Radiation Research Center (NSRRC), Taiwan. A triangular bent Si (111) single crystal was used to get a monochromated beam having a wavelength (λ) of 1.33 Å. The morphologies of the polymer samples were examined by Field emission scanning electron microscopy (FE-SEM; JEOL JSM7610F) and also by transmission electron microscope (TEM) using a JEOL-2100 instrument at an accelerating voltage of 200 kV. BET surface area and porosimetry measurements of samples (ca. 40–100 mg) were measured using BEL MasterTM/BEL simTM (v. 3.0.0). N₂ adsorption and desorption isotherms were generated through incremental exposure to ultrahigh-purity N₂ (up to ca. 1 atm) in a liquid N₂ (77 K) bath. Surface parameters were calculated using BET adsorption models in the instrument's software. The pore size of the prepared samples was determined by using nonlocal density functional theory (NLDFT).

Electrochemical Analysis

Working Electrode Cleaning: Prior to using, the glassy carbon electrode (GCE) was polished several times with 0.05-µm alumina powder, washed with EtOH after each polishing step, cleaned

through sonication (5 min) in a water bath, washed with EtOH, and then dried in the oven at 50 °C.

Electrochemical Characterization: The electrochemical experiments were performed in a threeelectrode cell using an Autolab potentiostat (PGSTAT204) and 1 M KOH as the aqueous electrolyte. The GCE was used as the working electrode (diameter: 5.61 mm; 0.2475 cm²); a Pt wire was used as the counter electrode; Hg/HgO (RE-1B, BAS) was the reference electrode. All reported potentials refer to the Hg/HgO potential. A slurry was prepared by dispersing TPET-Bimine CMP or PT-Bimine CMP or TPET-Im CMP or PT-Im CMP (2 mg), carbon black (2 mg), and Nafion (10 wt%) in a mixture of (EtOH/ H₂O) (200 µL: 800 µL) and then sonicating for 1 h. A portion of this slurry (10 µL) was pipetted onto the tip of the electrode, which was then dried in air for 30 min prior to use. The electrochemical performance was studied through CV at various sweep rates (5–200 mV s⁻¹) and through the GCD method in the potential range from 0 to -1.00 V (vs. Hg/HgO) at various current densities (0.5–20 A g⁻¹) in 1 M KOH as the aqueous electrolyte solution.

The specific capacitance was calculated from the GCD data using the equation.

$$C_{\rm s} = (I\Delta t)/(m\Delta V)$$

Where C_s (F g⁻¹) is the specific capacitance of the supercapacitor, I (A) is the discharge current, ΔV (V) is the potential window, Δt (s) is the discharge time, and m (g) is the mass of the NPC on the electrode. The energy density (E, W h kg⁻¹) and power density (P, W kg⁻¹) were calculated using the equations.

$$E = 1000C(\Delta V)^2/(2 \times 3600)$$

P = E/(t/3600)

Electrochemical Analysis in Two-Electrode Symmetric Supercapacitor System

The slurry prepared by mixing TPET-Bimine CMP or PT-Bimine CMP or TPET-Im CMP or PT-Im CMP, carbon black, and Nafion (10 wt. %) was coated onto a flexible Kuraray carbon paper (0.1 mm in thickness) with an effective area of 1 cm × 1 cm and then dried at 100 °C overnight in a vacuum oven. The mass loading of active material on the current collector was 0.8 mg cm⁻². The two working electrodes were separated with filter paper and infiltrated with potassium hydroxide (1 M) aqueous solution.

The specific capacitance was calculated from galvanostatic charge-discharge experiments using the following equation:

$$Cs = 2 x (I\Delta t)/(m\Delta V)$$

Where Cs (F/g) is specific capacitance of the supercapacitor, I (A) is the discharge current, ΔV (V) is the potential window, Δt (s) is the discharge time, and m (g) is the mass of porous carbon on the one electrode. The energy density (E, Wh kg⁻¹) and power density (P, W kg⁻¹) were calculated using the equations.

 $E = 1000C(\Delta V)^2/(4 \times 7.2)$

P = E/(t/3600)



Scheme S1. Synthesis of Bimine-Br₂.



Scheme S2. Synthesis of TPET-Bimine CMP.



Scheme S3. Synthesis of PT-Bimine CMP.



Scheme S4. Synthesis of TPET-Im CMP.



Scheme S5. Synthesis of PT-Im CMP.



Figure S1. FTIR spectrum of Bimine-Br₂.



Figure S2. ¹H-NMR spectrum of Bimine-Br₂.



Figure S3. ¹³C-NMR spectrum of Bimine-Br₂.



Figure S4. TGA spectrum of Bimine-Br₂.



Figure S5. The placement of the bacterial solution on the agar plate after dilution and dropping.



Figure S6. Corresponding XRD profiles of TPET-Bimine and PT-Bimine CMPs.



Figure S7. The redox reaction of N atom in TPET-Bimine and TPET-Im CMPs.



Figure S8. Electrochemical impedance spectrometry curves: (a) Nyquist plots and (b) equivalent fitted circuit, (c) Bode plot of frequency-dependent resistance (magnitude), and (d) Bode plot of frequency-dependent phase angles of TPET-Bimine CMP, PT-Bimine CMP, TPET-Im CMP and PT-Im CMP.



Figure S9. CV (a-d) and GCD (e-h) profiles of TPET-Bimine CMP (a, e), PT-Bimine CMP (b, f), TPET-Im CMP (c, g), and PT-Im CMP (d, h) based on a symmetric coin cell.



Figure S10. (a) Specific capacitance and (b) Ragone profile of TPET-Bimine CMP, PT-Bimine CMP, TPET-Im CMP and PT-Im CMP based on a symmetric coin cell.

Table S1. Comparison between the capacity values of TPET-Bimine CMP, PT-Bimine CMP, TPET-Im CMP, and PT-Im CMP with different reported data of three electrode supercapacitor materials.

Electrode	Capacitance	Ref.
TPET-Bimine CMP	34 F g ⁻¹ at 0.5 A g ⁻¹	This work
PT-Bimine CMP	37 F g ⁻¹ at 0.5 A g ⁻¹	This work
TPET-Im CMP	63 F g ⁻¹ at 0.5 A g ⁻¹	This work
PT-Im CMP	53 F g ⁻¹ at 0.5 A g ⁻¹	This work
Cz-Cz CMP	43.70 F g^{-1} at 0.5 A g^{-1}	S1
Cz-TP CMP	67.38 F g ⁻¹ at 1 A g ⁻¹	S1
POSS-F-POIP	$36.2 \text{ F g}^{-1} \text{ at } 0.5 \text{ A g}^{-1}$	S2
Н-ТНАО	$15 \text{ F g}^{-1} \text{ at } 1 \text{ A g}^{-1}$	S3
THAQ/rGO (2:1)	76 F g ⁻¹ at 1 A g ⁻¹	S3
Pure AQ	42 F g^{-1} at 1 A g^{-1}	S4
TPE-DDSQ-POIP	22 F g ⁻¹ at 1 A g ⁻¹	S5
Car-DDSQ-POIP	23 F g ⁻¹ at 1 A g ⁻¹	S5
OVS-A HPP	120 F g ⁻¹ at 0.5 A g ⁻¹	S 6
OVS-P-A HPP	177 F g ⁻¹ at 0.5 A g ⁻¹	S 6
Py-PDT POP	28 F g ⁻¹ at 0.5 A g ⁻¹	S7
TBN-BSU CMP	70 F g ⁻¹ at 0.5 A g ⁻¹	S8
Py-BSU CMP	38 F g ⁻¹ at 0.5 A g ⁻¹	S8
N- doped Porous carbons ropes	60 F g ⁻¹ at 1.0 A g ⁻¹	S9
TPE-FFC-CMP/CD-BZ	7.53 F g ⁻¹ at 0.5 A g ⁻¹	S10
TPE-FFC-CMP/poly (CD-BZ)	37.07 F g ⁻¹ at 0.5 A g ⁻¹	S10
Py-FFC-CMP/CD-BZ	10.15 F g ⁻¹ at 0.5 A g ⁻¹	S10
Py-FFC-CMP/poly (CD-BZ)	46 F g ⁻¹ at 0.5 A g ⁻¹	S10
HPC-0	48 F g ⁻¹ at 1 A g ⁻¹	S11

An-Ph-Py CMP	83 F g^{-1} at 1 A g^{-1}	S12
CoPc-CMP	13.8 F g ⁻¹ at 1 A g ⁻¹	S13
β -Ketoenamine-Linked Covalent Organic Frameworks (COF)	48 F g ⁻¹ at 0. 1 A g ⁻¹	S14
TBN-Car-CMP	18.45 F g ⁻¹ at 0.5 A g ⁻¹	S15
TPE-Ph-Th CMP	39 F g ⁻¹ at 0.5 A g ⁻¹	S16
TPE-Ph-Tha CMP	51 F g ⁻¹ at 0.5 A g ⁻¹	S16
TPE-Ph-BSu CMP	52 F g^{-1} at 0.5 A g^{-1}	S16
HOMCNSs	72.79 F g^{-1} at 0.5 A g^{-1}	S17
An-CPOP-1	72.72 F g^{-1} at 0.5 A g^{-1}	S18
An-CPOP-2	98.40 F g ⁻¹ at 0.5 A g ⁻¹	S18

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